

Daniel Kennedy Villa mums
18/3/87

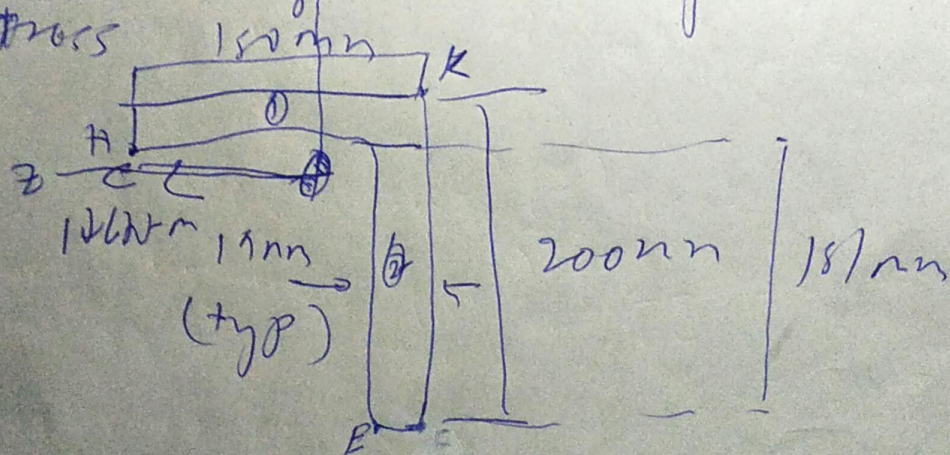
KCQ #1

Unsymmetric Bending

1. The moment acting on the cross-section of the unequal-leg angle has a magnitude of 14 kNm and is oriented as shown

Determine the following:

- 1.1. bending stress at point A
- 1.2. bending stress at point K
- 1.3. orientation of the principal axes
- 1.4. maximum torsion at supports bending stress



$$M_z = +14 \times 10^6 \text{ N-mm} = 14 \text{ kNm}$$

part A	$\bar{y}$ of part	$\bar{z}$ of part	h of part	b of part
1	110.5 mm	75 mm	15 mm	150 mm
2	90.5 mm	15.5 mm	18 mm	15 mm

$$\bar{y} = 135.82 \text{ mm}$$

$$\bar{z} = 35.18 \text{ mm}$$

$$I_y = 12.13 \times 10^6 \text{ mm}^4$$

$$I_z = 25.06 \times 10^6 \text{ mm}^4$$

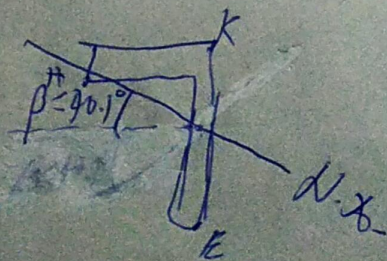
$$I_{yz} = 10.21 \times 10^6 \text{ mm}^4$$

$$\beta = 40.1^\circ$$

$$\sigma_x = y_{\text{coeff}} y + z_{\text{coeff}} z$$

$$y_{\text{coeff}} = -849.57 \times 10^{-3} \text{ N/mm}^2$$

$$z_{\text{coeff}} = 713.09 \times 10^{-3} \text{ N/mm}^2$$



Pro bottom right Pro bottom

Point	x	y	z	σ (MPa)
A	181 mm	152 mm	45.18 mm	110.82 MPa
K	200 mm	0 mm	68.18 mm	-35.18 MPa
E	0 mm	0 mm	-135.82 mm	-35.18 MPa

1.1

$$\sigma_A = 110.82 \text{ MPa (T)}$$

1.2

$$\sigma_K = 82.57 \text{ MPa (C)}$$

1.3

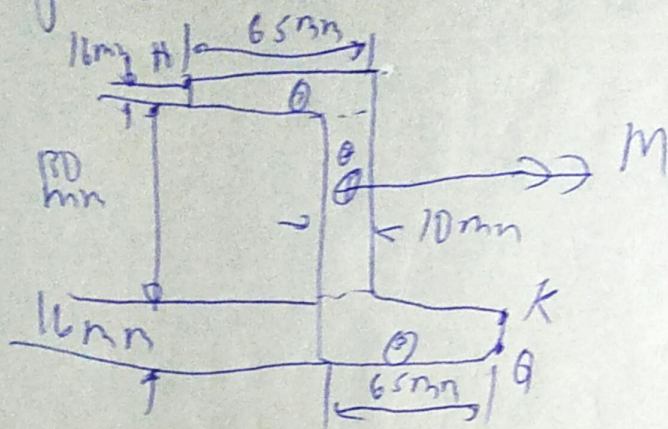
$$\beta = 40.1^\circ$$

1.4

$$\text{tension max} = 110.82 \text{ MPa (T)}$$

$$\text{compression max} = 82.57 \text{ MPa (C)}$$

2. For the figure shown, determine the maximum magnitude of the bending moment M so that the bending stress in the 2024 shape section does not exceed 205 MPa.



$$M_z = -M$$

part #	top part (mm)	2d part (mm)	hd part (mm)	3d part (mm)
1	154	87.5	16	65
2	81	60	130	10
3	8	32.5	16	65

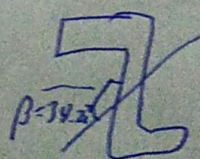
$$\bar{y} = 81 \text{ mm} \quad I_y = 2.32 \times 10^6 \text{ mm}^4$$

$$\bar{z} = 60 \text{ mm} \quad I_z = 12.96 \times 10^6 \text{ mm}^4$$

$$I_{yz} = 4.18 \times 10^6 \text{ mm}^4$$

$$\sigma_x = y_{\text{coeff}} y + z_{\text{coeff}} z$$

$$\tan \beta = \frac{M_y I_z + M_z I_{yz}}{M_z I_y + M_y I_{yz}}$$



Pos	from bottom flange (12mm)		from center of web (12mm)		loading stress
	y	z	y	z	initial stress
H	162	114	81	54	-207.72 MPa
K	16	0	-65	-60	548.77 MPa
Q	0	0	-81	-60	345.12 MPa

Initial guess of $M = 69 \times 10^6 \text{ N-mm}$ implies?

$$M_z = -89 \times 10^6 \text{ N-mm} \quad \tan \beta \text{ if } M_y \text{ is 0!}$$

$$\beta = 60.98^\circ$$

$$\gamma_{\text{coeff}} = 12.70 \text{ N/mm}^2 \quad \tan \beta = \frac{0(I_z) + M_z I_{yz}}{M_z I_y + 0(I_z)}$$

$$z_{\text{coeff}} = -22.90 \text{ N/mm}^2$$

$$\tan \beta = \frac{I_{yz}}{I_y} \Rightarrow \beta = 60.98^\circ$$

Solve

(Gibb's nonlinear) finds: $M = 25.79 \times 10^6 \text{ N-mm} = 25.79 \text{ kN-m}$

Check:

Pos	σ	$M_z = -M$
H	-77.65 = 77.65 MPa (C)	$M_z = -25.79 \times 10^6 \text{ N-mm}$
K	205 = 205 MPa (T)	$\beta = 60.98^\circ$
Q	121.02 = 121.02 MPa (T)	$\gamma_{\text{coeff}} = 4.75 \text{ N/mm}^2$
max	205 = 125.02 MPa (T)	$z_{\text{coeff}} = -8.56 \text{ N/mm}^2$

Therefore:

$$M = 25.79 \text{ kN-m}$$